Space Weather Technical Forecast

Issued on Tuesday, 18 April 2023 at 12:38 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storms likely 20-21 Apr due to CME arrival, with a slight chance of G2/Moderate or G3/Strong Storms. Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the last 24 hours, with a peak flare a C6.9 event from AR3281 at 17/1431UTC. There are currently eight sunspot regions on the visible disc. The largest region is AR3282 in the northern hemisphere near centre disc. This area has a large longitudinal extent with few spots between the large leader and trailer spot. A succession of sunspot groups persists around 20S latitude with AR3279, followed by AR3281 and then AR3283. The regions are relatively simple and stable, although appear to be interacting magnetically. AR3284 near the eastern limb has shown some slight growth in leader and trailer spots, though also appears magnetically simple at present. All other regions are small and simple. No Earth-directed CME have been observed in available imagery during the last 24 hours. A coronal dimming evident starting around 17/1200 UTC in the northern centre disc does not appear to have resulted in any clear CME signatures.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 started at slow-ambient levels but with steadily increasing speed, suggesting a weak coronal hole high speed stream connection, possibly CH92 or CH93 in the far west. Speeds increased to around 480km/s (slightly elevated) by the end of the period. Density was at largely below average levels. Total magnetic field, IMF, was generally weak, but occasionally moderate between 17/1230 and 18/0430 UTC. The north-south component has also mainly varied weakly, but a peak of 11nT was observed at 17/2156 UTC and -8nT at 17/1246 UTC. The phi angle was generally negative (away from the sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background to moderate levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a steady trend, with 1.35e6 integrated pfu observed at 18/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be generally Low, with a likelihood of isolated Moderate activity, mainly due to AR3282. There is also a chance for activity from a region beyond the northeastern limb, which is forecast to rotate onto the visible disc in the coming days.

Solar Wind / Geomagnetic Activity: Two CMEs may affect the Earth in this period. One, as a low confidence glancing blow on 19 Apr, with a further more direct near full halo, expected on 20 or 21 Apr. Otherwise solar winds are expected to remain between slightly elevated and background levels, with an initial period more predominantly at slightly elevated levels as a result of weak coronal hole high speed streams connections.

Geomagnetic activity is forecast to be Quiet to Unsettled on 18 Apr and much of if not all of 19 Apr. There is a very slight chance of G1/Minor storm intervals due to the potential glancing CME

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on 19 Apr. Activity is expected to reach Active to G1/Minor Storm levels on 20 or 21 Apr due to the anticipated CME arrival, with a chance of G2/Moderate or G3/Strong Storm conditions.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is most likely to persist at background levels, although there is a very slight chance of a S1 or greater event. High energy (greater than 2 MeV) electron flux is currently at background to moderate levels with little change probable throughout much of the period. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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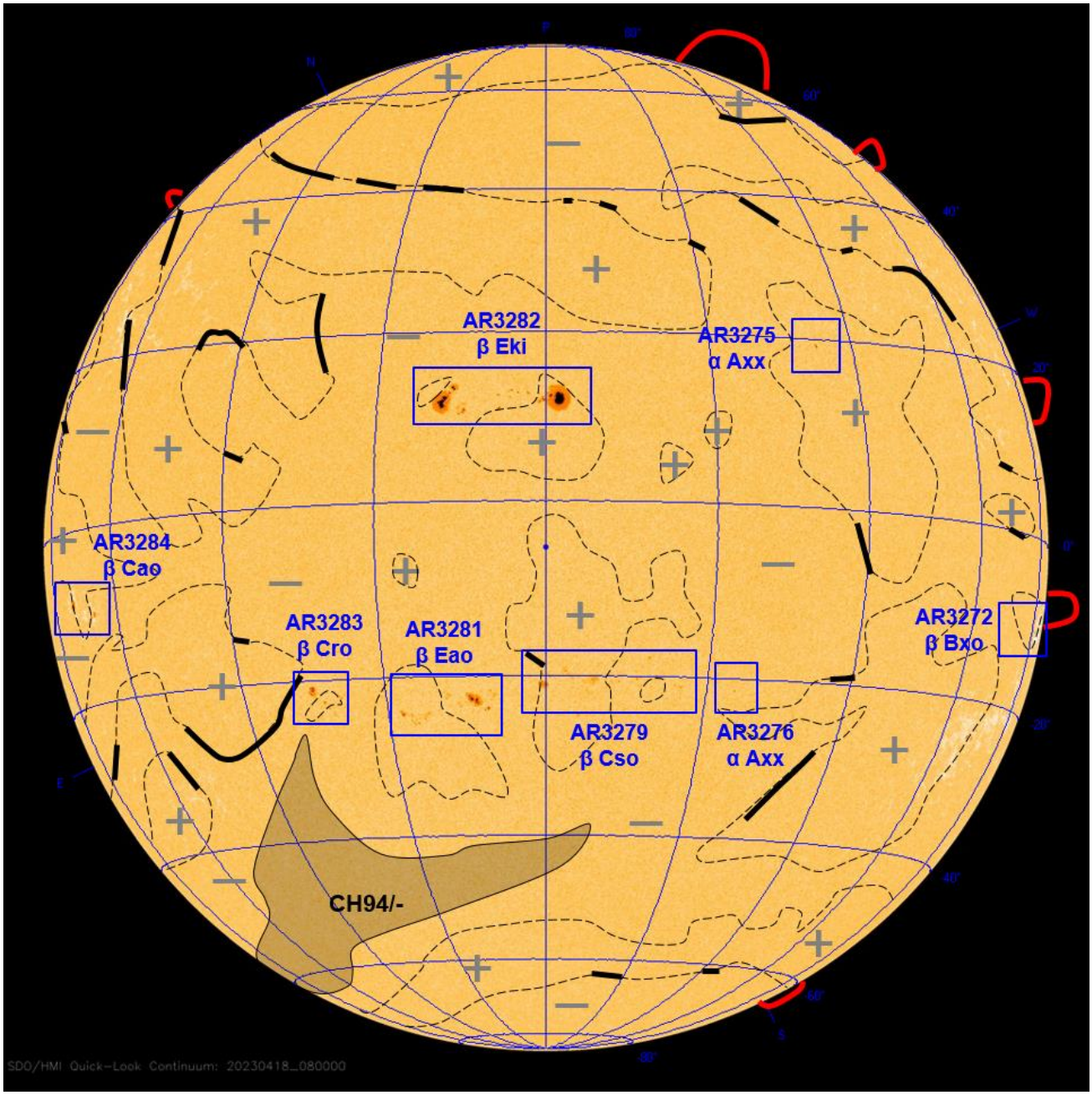
Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A couple of CMEs have been analysed with the potential to affect Earth during the forecast period. The first, a filament eruption at around 15/1100UTC is forecast to potentially glance the Earth on 19 Apr, but the majority if not all of the CME is expected to pass behind Earth-orbit. A feint CME halo from a large filament eruption later that same day that occurred at 15/2324UTC is more likely to affect Earth, arriving on either 20 or 21 Apr. Confidence in the arrival time and geomagnetic effects is only moderate given the apparent diffuse signature of the CME in LASCO C2 and C3 imagery and limited STEREO A data for the event. Additionally, Enlil background wind speeds are around 100km/s lower at present than in current observations. This means that the expected arrival time of the CME in the model is likely later than should be expected in reality. A broad expected arrival window from early on 20 Apr until the end of 21 Apr is the most likely arrival time of the CME.

Earth appears to be connected to a weak high-speed stream, probably from either CH92 or CH93 with slightly elevated solar winds. This connection should peak in the next 24 hours, followed by a decline ahead of any possible CME arrivals between 19-21 Apr. The next CH high-speed stream is not expected to become geo-effective until around 23 Apr, although given the high southern latitude of the feature, any connection carries rather low confidence.

Geomagnetic activity is forecast to be Quiet to Unsettled on 18 Apr and much of if not all of 19 Apr. There is a very slight chance of G1/Minor storm intervals due to the potential glancing CME on 19 Apr. Activity is expected to reach Active to G1/Minor Storm levels on 20 or 21 Apr due to the anticipated CME arrival, with a chance of G2/Moderate or G3/Strong Storm conditions.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	60	60
Strong	G3	No	1	1	30	30
Severe	G4	No	1	1	5	5
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0550	Partial	Filament eruption	NW	250 km/s	19/1200 +/- 9 hours	Low confidence
16/1343	Full	Filament eruption	NW	350 km/s	20/1300 +/- 9 hours	Possible G2/G3 storms. Low confidence.

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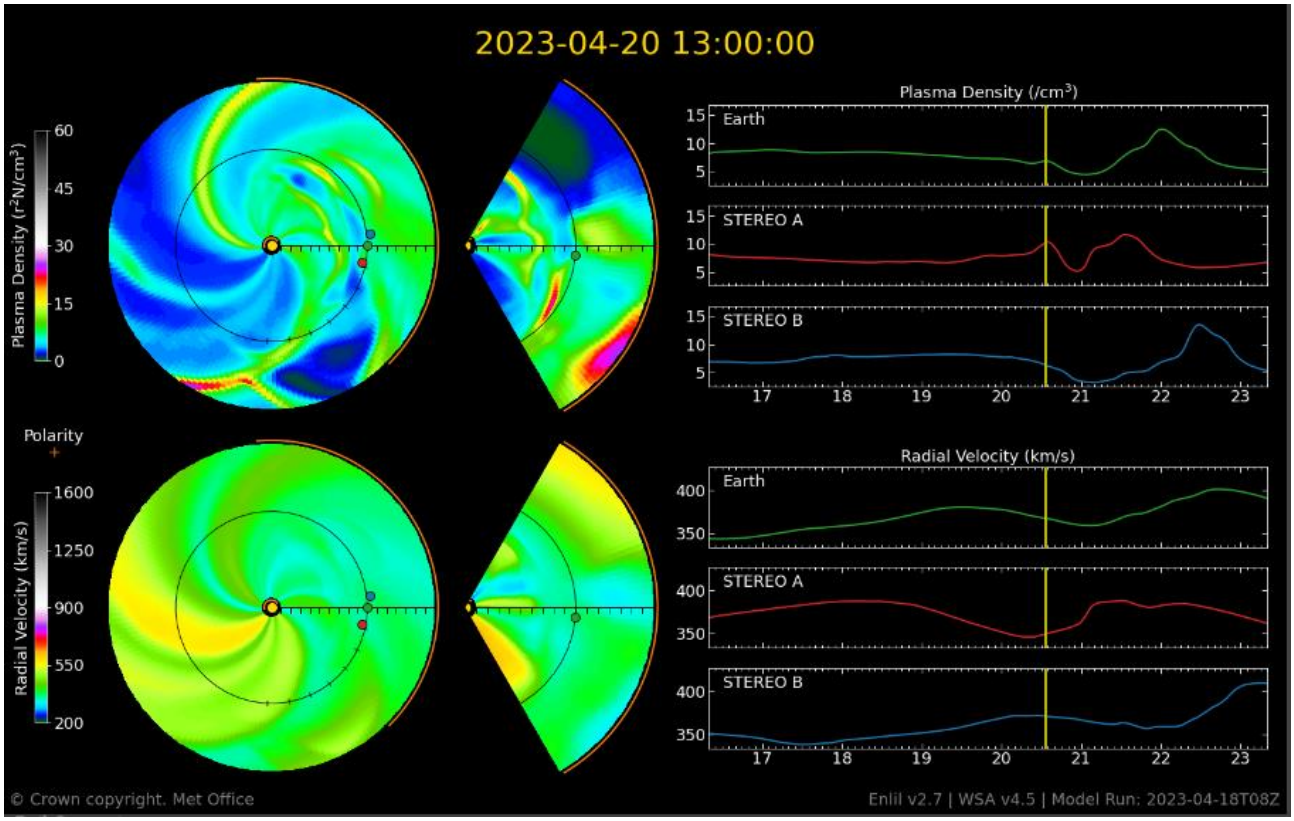
Figure 2: Latest ENLIL output. CME from 15/16 Apr delayed in model compared to forecast arrival at Earth due to slower background winds than in reality.



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Radio Blackouts - X-Ray Flares:

There are eight active regions on the visible disc, AR3282 is the largest and most prominent region as it approaches centre disc in the northern hemisphere. In general there has been little change in the appearance of the group and has been generally inactive with a large longitudinal extent. There is some slight evidence for some emergence of small intermediate spots and this region still poses the greatest risk for significant flares at present.

A succession of sunspot groups persists around 20S latitude with AR3279, followed by AR3281 and then AR3283. The regions are relatively simple and stable, although appear to be interacting magnetically. AR3284 near the eastern limb has shown some slight growth in leader and trailer spots, though also appears magnetically simple at present. All other regions are small and simple.

A new region beyond the northeast limb appears bright on SDO AIA 94 imagery and could reveal a sunspot group as it rotates onto the visible disc in the next day or so. The position of the group would match up with Ex-AR3264 from the previous rotation.

Low solar activity is predicted in general, with a likelihood of isolated M-class flares and a very slight chance of X-class flaring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period. AR3280 which recently rotated over the western limb, carries the greatest risk of a proton event early in the period. A number of fairly complex regions in the east could also produce some proton response from any particularly energetic events, with these acting to maintain the very slight risk through much of the guidance period as they continue to rotate westward.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

As the solar wind is relatively muted with no significant high speed streams to feed electrons into the radiation belts, or solar wind pressure to suppress the belts into lower orbits the high energy electron flux (greater than 2MeV) has been at background and is expected to remain so for much of the forecast period. Enhanced geomagnetic activity due to forecast CME arrivals between 19-21 Apr could prolong this depression, with a gradual increase most likely beyond the end of the forecast period as the geomagnetic activity fades.

Electron fluence is expected to remain below the Active threshold due to the forecast geomagnetic enhancements.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 3: Latest GOES-16 Electron Flux and MOSWOC REFM output.

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